Building High-Performance, Scalable Applications

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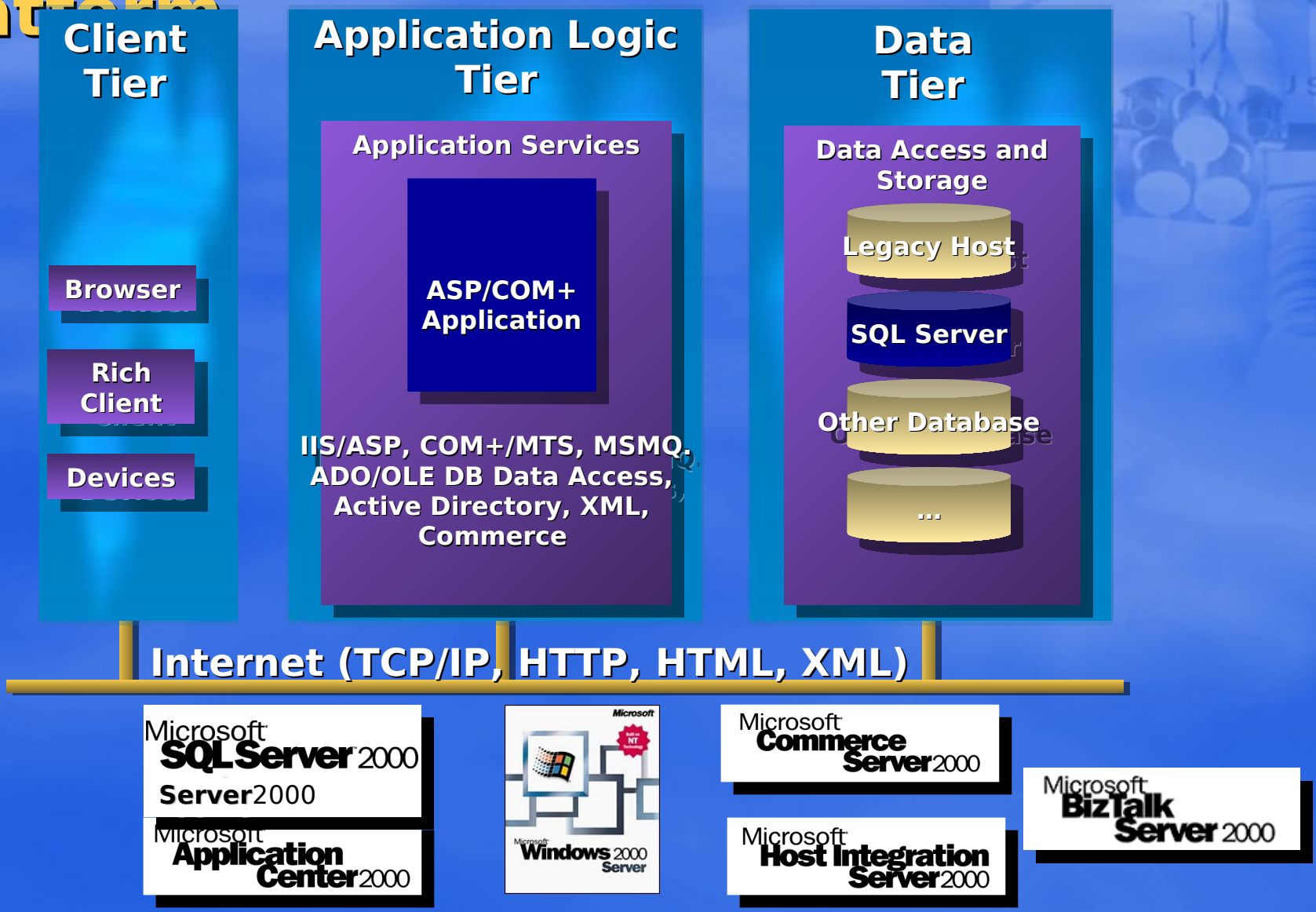
POWER UP
Windows DNA 2000
Readiness Conference
featuring SQL Server 2000

Objectives

- SQL Server™ performance and scalability from an application development perspective
- Key performance characteristics

Windows DNA 2000

Next Generation Web Application Platform



SQL Server Performance

- Self configuring, managing, tuning
  - Dynamic memory/lock management
  - Auto stats creation/update
  - Fully integrated intra-query parallelism
  - Automated index tuning
  - Intelligent I/O
  - More…

Agenda

- Plan caching
- Cursors
- SQL Server 2000 performance enhancements

Plan Cache

- Optimizer compiles query tree into an execution plan
  - Normalization
  - Optimization (cost-based) uses stats
  - Prune heuristics
- Execution plan – data structure
- Stored in plan cache

Plan Caching

- Ad-hoc workloads
  - Adhoc caching
  - Auto parameterization
- Defined workloads
  - Stored procedures
  - ExecuteSQL
  - Prepare / Execute / Unprepare

Ad-Hoc Plan Caching

- Cache the plan from adhoc statements
- Subsequent statement has the exact exact textual match

  Example:

  Q1: select * from employees where fname like ‘S%’

  Q2: select * from employees where fname like ‘D%’

  Q3: select * from employees where fname like ‘S%’

  - Q3 will used cached plan from Q1
  - Q2 needs to be compiled

Auto-Parameterization

- Only on “simple” statements
- Determines constants that are probably/could be parameters
- Parameterized template is created
- Other queries can use template if “safe”
- Recommendation:
  Do not rely on this for defined workloads

Auto-Parameterization Forms

- INSERT <table> VALUES ({constant} | NULL | DEFAULT}, ..)
- DELETE <table> WHERE <key-exp>
- UPDATE <table> SET <col> = <constant> WHERE <key-exp>
- SELECT <col-list> FROM <table> WHERE <key-exp> ORDER BY <col-list>

Auto-Parameterization

- Safe
  - Template: INT @P, SELECT fname, lname FROM employees WHERE emp_id = @P
- Unsafe
  - SELECT fname, lname FROM employees WHERE (salary + bonus) > 30000
- Optimizer decision

Stored Procedures

- Batch of statements stored within the server
- Persistent object management
- Parameters are specified by the application
- Plans are compiled / cached on execution
  - WITH RECOMPILE option
- Dynamic statements with SP

Stored Procedures

- Business logic closest to data
- Performance
  - Next number generation
  - Minimizes network traffic
  - RPC execution avoids parameter processing and statement parsing
- UDFs

ExecuteSQL

- Created by application
- Does not require persistent object management

Example:

```
Sp_execute('insert TableA values (@p)','@p float',1)
Sp_execute('insert TableA values (@p)','@p float',3)
Sp_execute('insert TableA values (@p)','@p float',1)
```

- Same cache plan will be used
- SQLExecDirect, IcommandWithParameters

Prepare / Execute

- Created by the application
- Text of batch is sent once on Prepare
- A handle will be used to repeatedly Execute
- Cleaned from the DBMS at UnPrepare
- SQLPrepare/SQLExecute, ICommandPrepare

Inappropriate Plan Sharing

- Re-using avoids compilation and optimization
- Optimal execution time
  - Not achieved if not using the optimal plan for given parameter values

Example:

```
Select * from T where c>=5 and c<=10 (index lookup)
Select * from T where c>=5 and c<=100 (table scan)
```

Issue: ExecSQL Versus Prepare / Execute

- Database driver
  - Isolated from the application logic
  - Special casing
  - Passing hints
- Predicting usage by user
- Application server
- N+2 costing

SQL Server 2000 Enhancements

- Reduced roundtrips with Prepare/Execute
  - Types of all parameters specified
  - Result-set meta data is not requested between prepare and execute
  - The number of round-trips for N executions is now N

SQL Server 2000 Enhancements

- **Reduced meta-data overhead**
  - **Selects – meta data for each column**
    - **meta-data is cached on the client-side (prepare/execute)**
  - **Parameter processing/meta-data**
    - **large cost for wide tables (30%)**
    - **Optimization on the SQL Server client**
    - **Only data values and data length is read**

Recommendations

- Stored procedures
- Use Prepare/Execute instead of SQLExecute
  - Share connection
- Parameterization when possible
  - Range of values should not change drastically
  - App should specify types of parameters
- Sharing rules

Cursors – Why?

- Applications - database driver isolation
- Scroll/update within rowset
- Requirement for multiple statements per connection
- Possibility of a small subset of rows used, from requested total
- Other application requirements

Efficient Use Of Cursors

- Subtle changes in cursor types can have a big impart on performance as you scale up
- Choose lowest cost cursor for your requirements
  - Default row set, fast forward only
  - Unless there are functionality requirements from the ‘rich’ cursor models
- Impact on server and n/w resources
- Respect Transactional control (isolation levels)

Default Result Set – Firehose

- ‘Base’ model – single SQL statement
- Full consumption of result set
- Small result set – esp. singletons
- Benefits
  - Minimize server resources
  - ‘Request’ not required
- Issue: connection busy until results consumed

Fast Forward Only

- Optimized forward-only, read-only cursors
- Connection busy minimized – multiple statements
- Thin layer over the query
- Operates directly on base table(s)
- Supports only fetch next
- Reflects committed changes to data

Static Cursors

- Snapshot of answer set is materialized in a temp table at cursor open
- Read only – underlying tables cannot be updated
- All scrolling options are available
- Not ‘dynamic’

Keyset Cursors

- Creates a keyset of the answer rowset in a temp table at cursor open
- All scrolling options are available
- Requires a unique index on every table in the select
- Obtains non-index columns from data pages
- Updates visible
- Membership is fixed – fetch to absolute position

Dynamic Cursors

- Operate directly on base table
- All scroll options available except absolute position
- All changes visible when scrolling
- Limited join techniques
- Downgrade possible

Cursor Downgrade

- Generally when materialization of the answer set on the server is required
  - Depending on original request
    - ORDER BY not covered by an index
    - TOP, GROUP BY, UNION, DISTINCT…
  - Can downgrade to static, keyset or dynamic
  - Subject to change when product is enhanced
- Recommendation: TEST
  - SQL_SUCCESS_WITH_INFO

Static / Keyset

- Static
  - Entire answer set materialized
  - Cheapest subsequent fetch
- Keyset
  - Rids / keys materialized
  - Other columns are fetched
  - Next cheapest fetch
- Asynchronous population
  - Sp_configure ‘cursor threshold’ n

SQL Server 2000 Enhancements - Cursors

- Internal
  - Cursor compile plan
  - Cursor execution plan
  - Fetch next for static and keysets
  - Keyset fetch
  - Cursor foot print (memory)

SQL Server 2000 Enhancements - Singletons

- Selects (general)
  - Eliminating memcopies
  - Speeding column access
- IRow interface (OLE/DB)
  - Direct access to columns of a single row object
  - Forward sequential access

General Performance

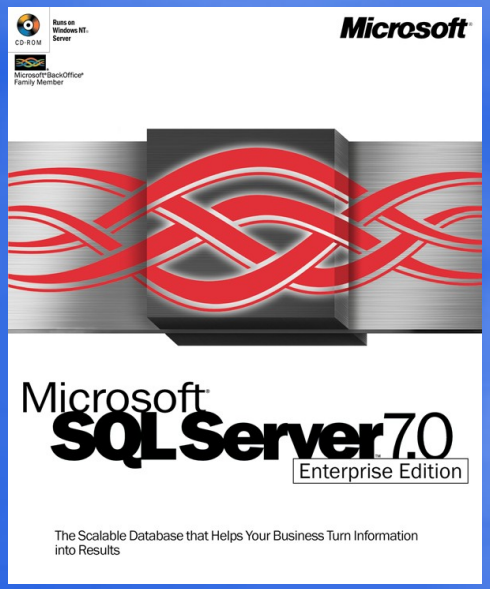
- Processing ‘Default’ parameters
  - Flag from first/previous insert
- Speeding up batch processing (inserts and selects)
  - Combine inserts
- Shared memory netlib (NT)
- SAN technology

Connection Pooling

- Reuse client connection to DB server
- Performance gains from reduced network traffic/latency and server CPU
- Driver determines when a connection should be dropped
- Pool behavior

SQL Server today…

- CRM
- ERP
- E-Commerce
- Data Warehousing



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Scaling Considerations

- Server resources – many concurrent users
- Dynamic requirements
- Processing, cleanup
- Network roundtrips

Summary

- Ensure strong plan caching
  - Stored procedures
  - Prepare/Execute
  - Parameterize
- Cursors
  - Use cost effective cursors
  - Test for downgrade
- Many optimizations in SQL Server 2000 - automatically

More Information

- Books on Line
- Beta2 News groups

  Microsoft.beta.Shiloh.*
- SQL Server 7.0 Home page

  http://www.microsoft.com/sql/
- Microsoft Product Support Services

  http://search.support.microsoft.com

Questions?

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POWER UP

Microsoft